Coupling Studies at CLS

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March 14, 2024

Basic Approach

- Use single bunch beam transfer function measurement feature of iGp12 to study beam response at different coupling settings;
- Initial measurements on 2024-02-05:
  - Skew quadrupoles off;
  - Closest approach tune scan suggests 0.35% coupling.
- Two tune scans on 2024-02-26:
  - Lower and higher settings of skew quadrupoles;
  - Correspond to approximately 1.4% and 2.5% coupling.

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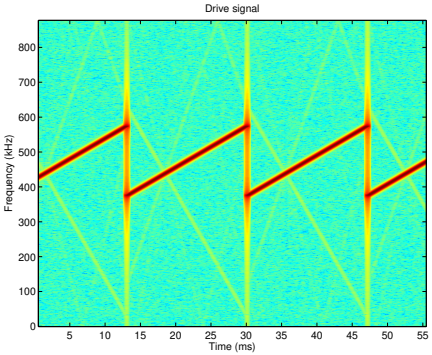

- Single bunch in the machine excited by a swept sinewave:
  - 200 kHz span;
  - 17 ms period.
- Bunch response in time domain;
- Transfer function is estimated using synchronously captured excitation and response
- Zoom in around the resonance;
- Fit the transfer function for better estimation of the tune and the phase shift on resonance.

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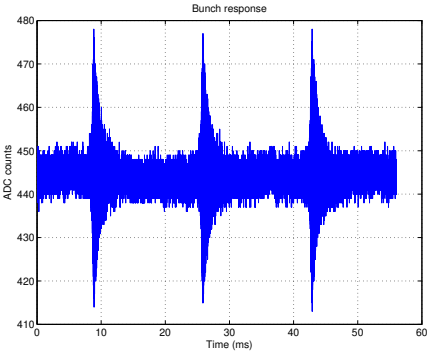

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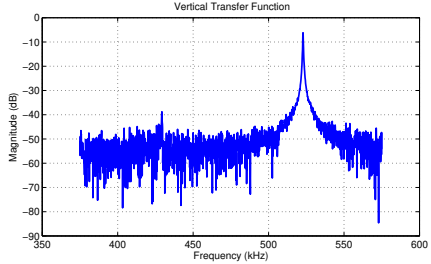

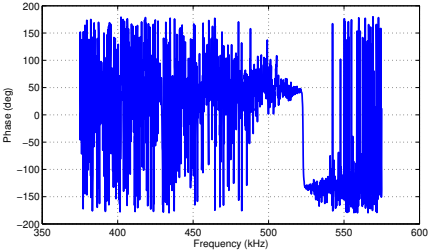

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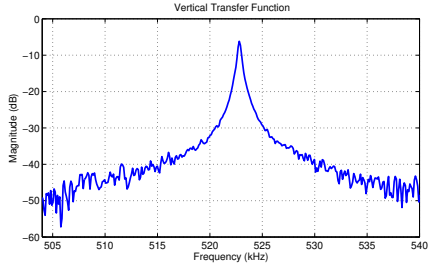

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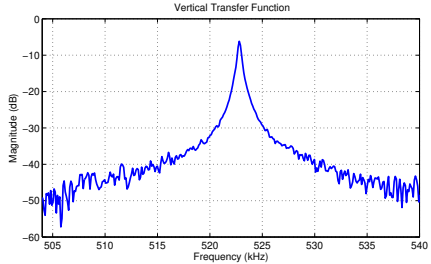

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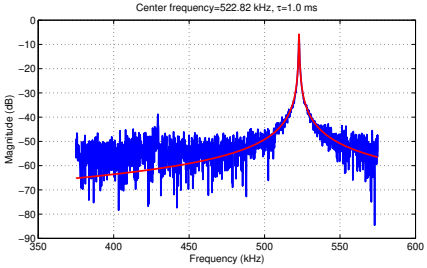
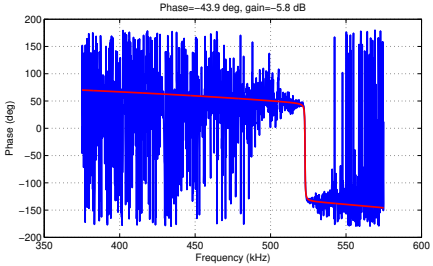
Transfer Function Fitting





- Using Fast Relaxed Vector Fitting (FRVF), Matlab `vectfit3()` from VFIT3 package [1, 2, 3]
- Good fit near the resonance;
- In the complex plane.

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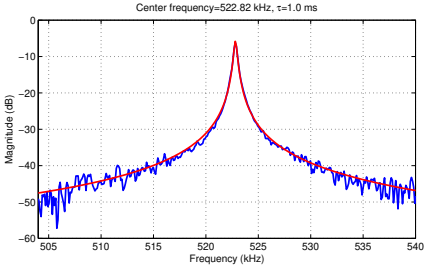

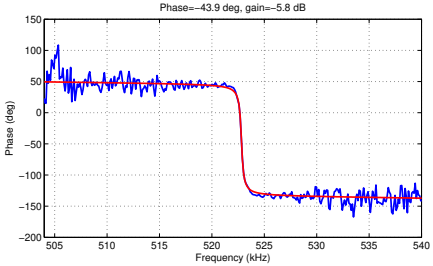

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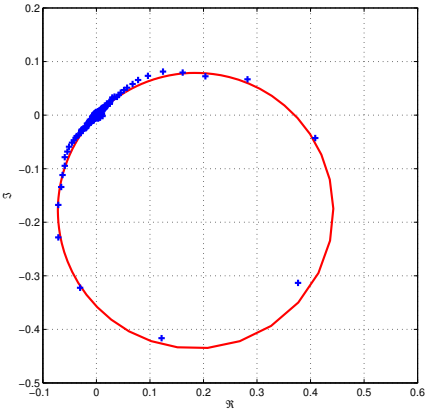

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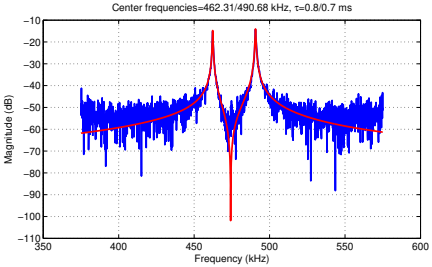
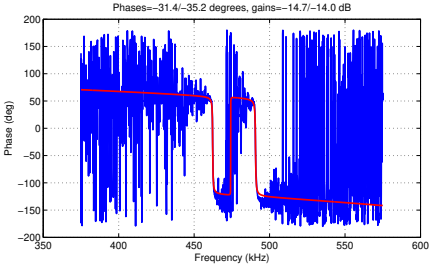
Dual Peak Fitting





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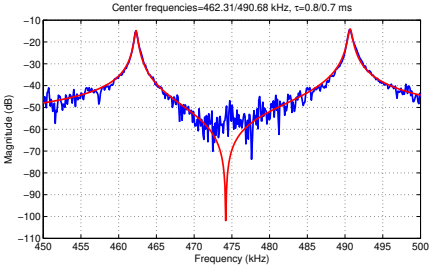

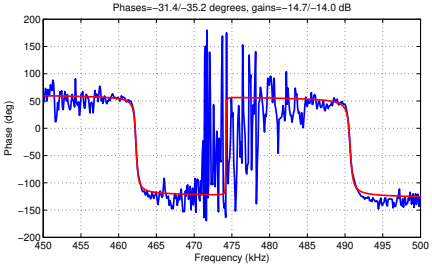

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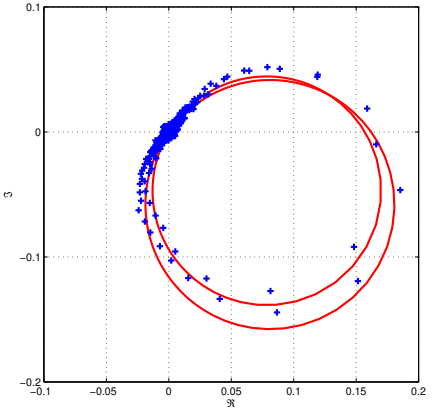

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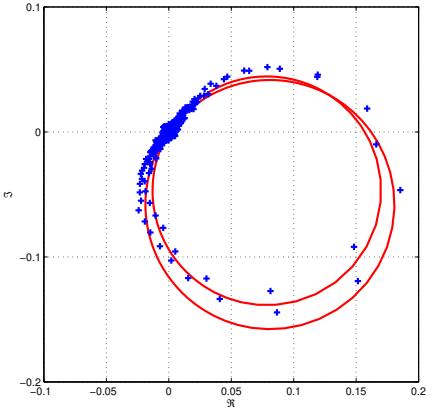

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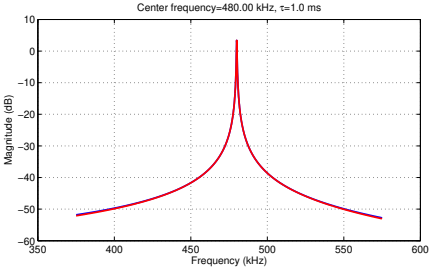

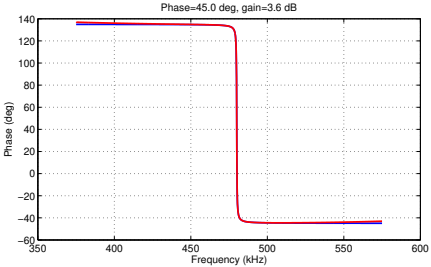

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- Very clean fit, values are spot on;
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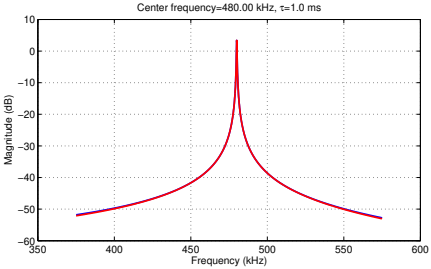

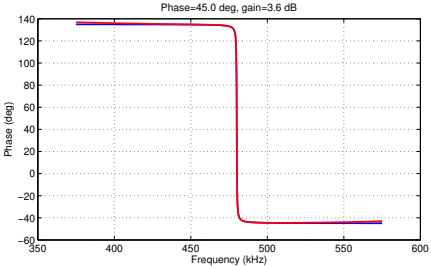

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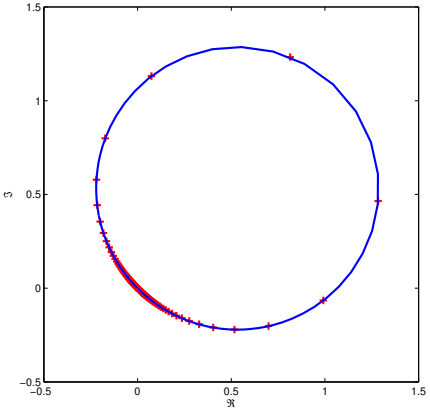

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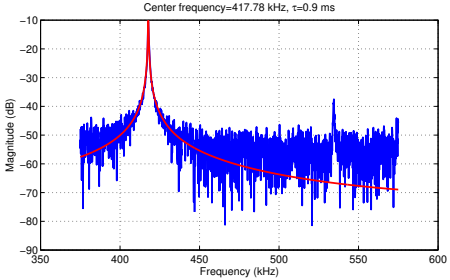
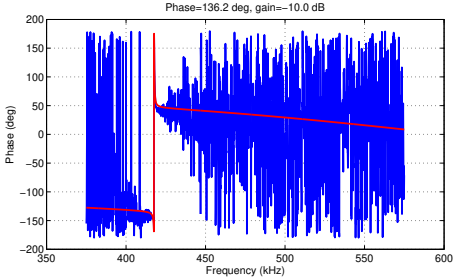
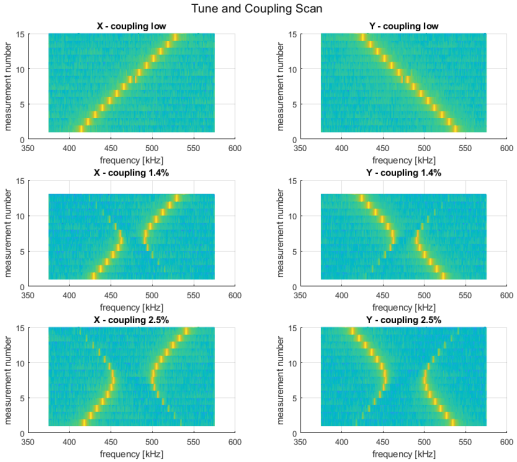




- Fits and data, horizontal plane, 15 measurements.

Tune Scan Results: Frequency



- Magnitude responses summarized;
- Medium skew quadrupole current (value?);
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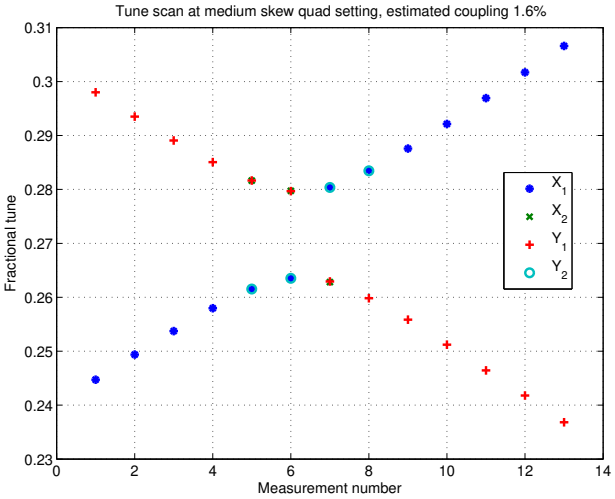

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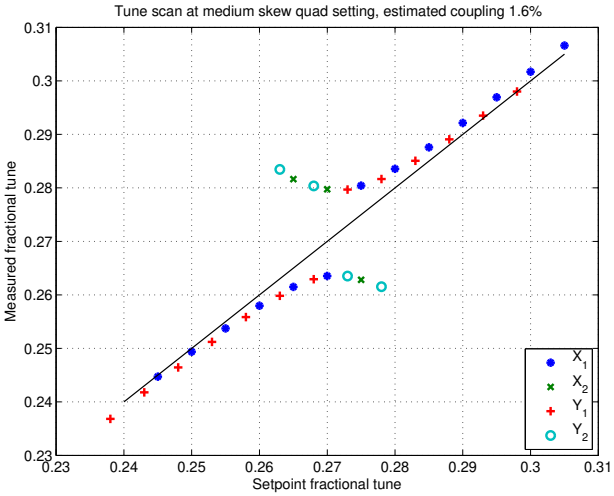

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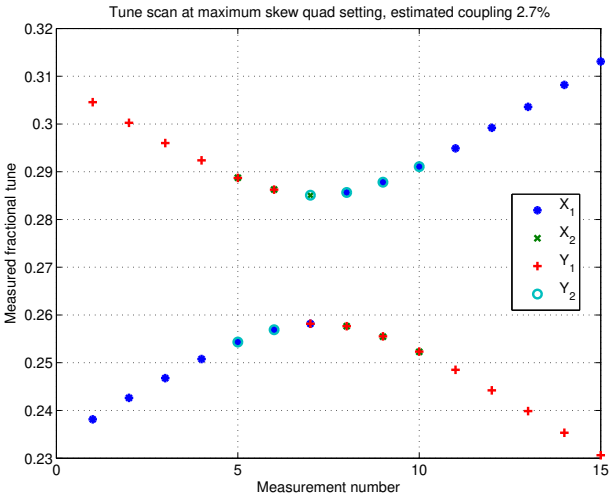

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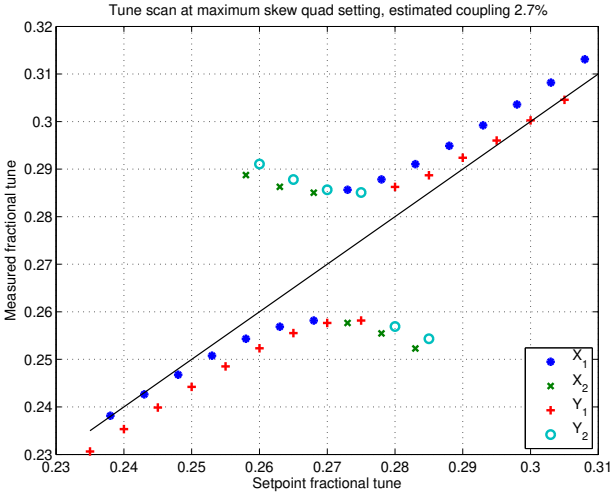

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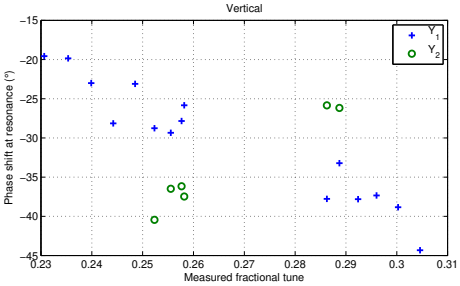

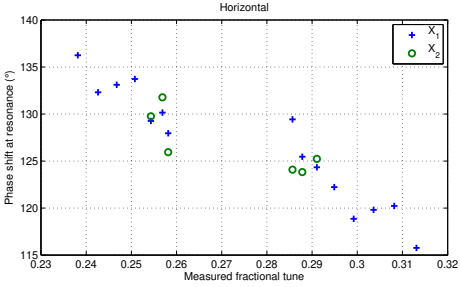

- Estimated phase shift at resonance vs. estimated tune;
- Based on optics, expect little phase advance between kicker and pickup in either plane;
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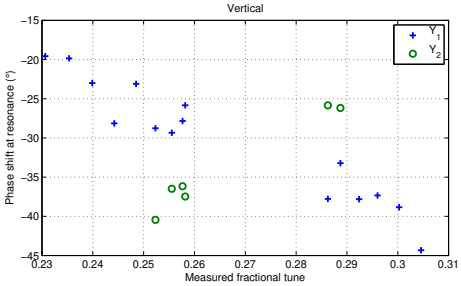

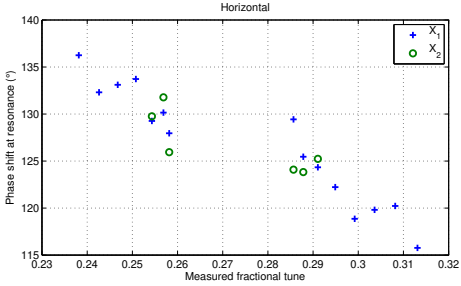

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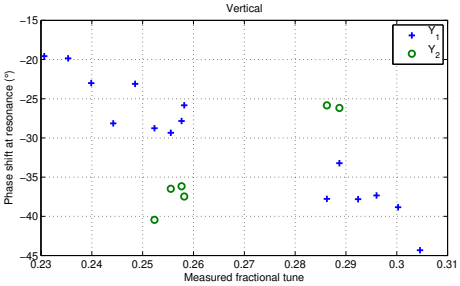

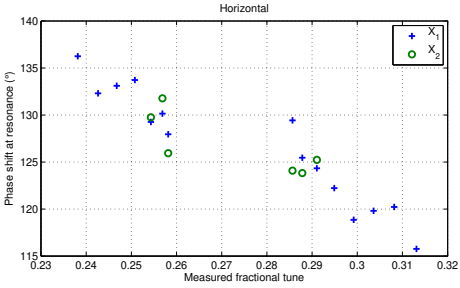

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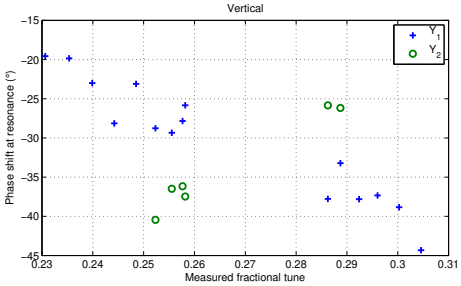

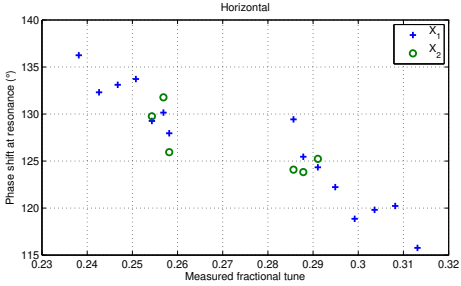

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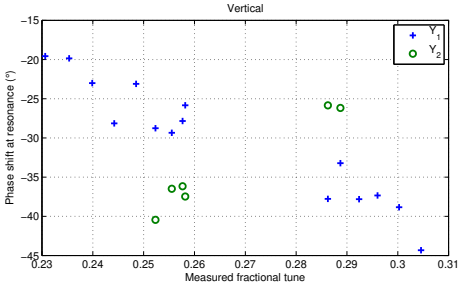

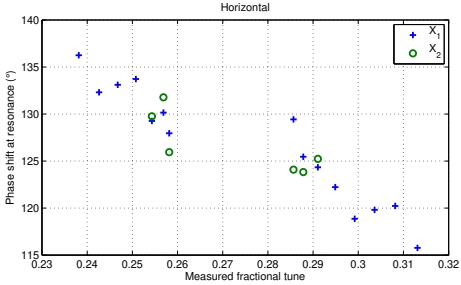

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- How well can we estimate kicker to pickup phase advance from the BTF response?

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